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(54) Audio communications systems

(57) An electrical circuit, for use in a headset communications system for wear in an environment with a high level of background noise, has an attenuator 5 which receives a combined noise and speech input signal 1 and a monitor 6 which monitors the input signal and controls operation of the attenuator. When no speech input is detected, and the noise input at least exceeds a pre-set level, the input signal is attenuated by between about 10 to 20 dB to prevent a high noise level in the output signal, yet still allow the headset wearers to be aware of the environment surrounding the circuit's input microphone(s). A low noise inhibit circuit 12 inhibits the attenuator when little or no background noise is present. The attenuation varies with input frequency, being generally constant at lower noise frequencies and increasing at higher noise frequencies to compensate for the fall-off in performance of noise cancelling microphones above 1KHz.

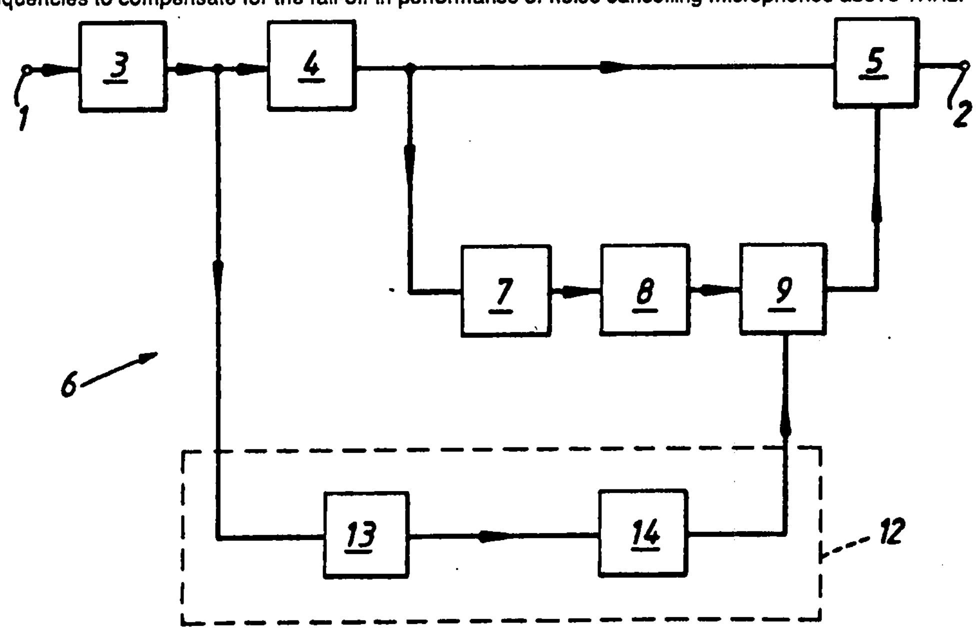

Fig.1.

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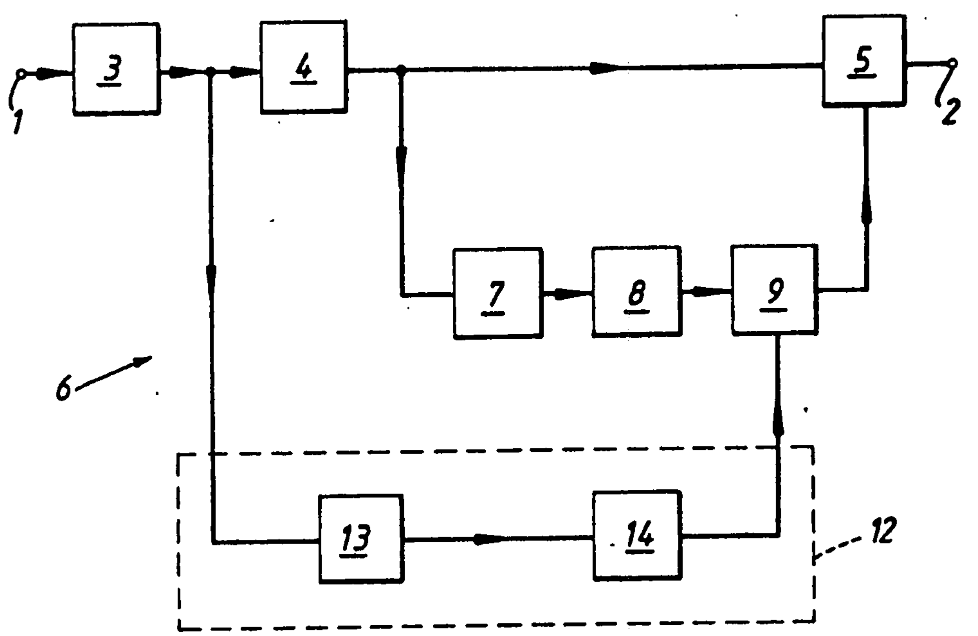

Fig.1.

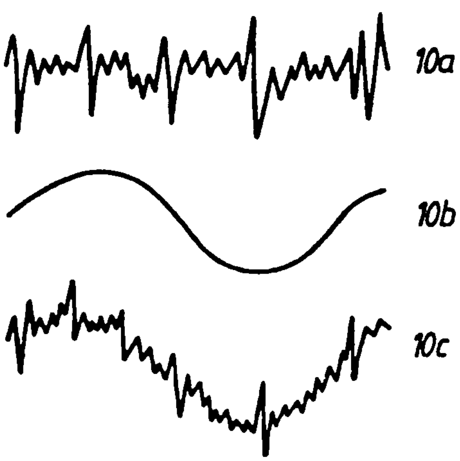

Fig.2.

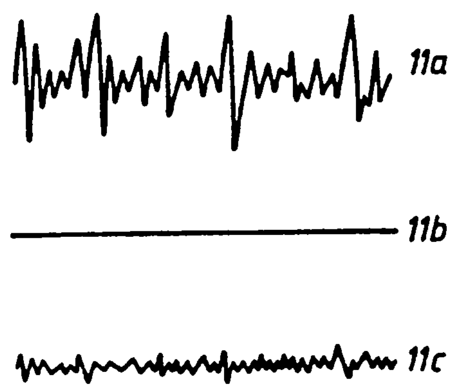

Fig.3.

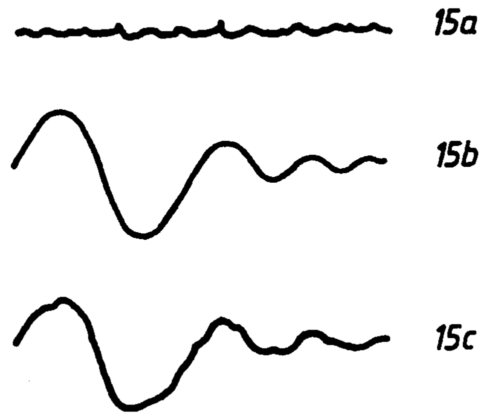

Fig.4.

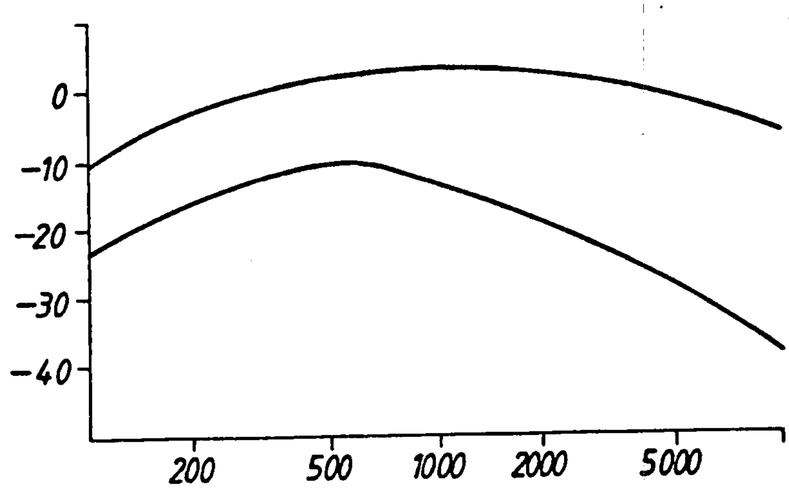

Fig.5.

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Improvements in and relating to communications systems

This invention relates to an audio signal transmission circuit particularly to an audio signal transmission circuit for use in a communication system.

When two or more people are working in a noisy environment, they may need to be provided with an intercommunication system comprising microphones and earphones, to allow them to communicate verbally with one another. Such a system should ideally allow for "hands free" operation.

A simple system, in which the microphones are "open" permanently, has the disadvantage that the noise is transmitted all the time, even when there is no speech, which can be fatiguing. It has been proposed to improve on this simple system by adding a voice operated switch, which switches the input by 40 dB plus to block the passage of noise when there is no speech. Such a system has disadvantages, including providing a "dead" sensation when there is no speech present, causing the users to frequently seek reassurance that the system is working by talking unnecessarily as a confidence check, and clipping the first syllables of speech.

According to one aspect of the present invention there is provided an audio signal transmission circuit comprising attenuator means adapted to receive a combined speech and noise input signal and means for monitoring the input signal, said monitoring means being arranged to control the operation of said attenuator means to attenuate the input signal, when both the level of the noise input signal at least exceeds a threshold level and the monitoring means detects no speech input signal, by an amount such that at least a part of any noise input signal is continuously passed.

The monitoring means may be arranged to control the operation of the attenuator means to attenuate the input signal only when the level of the noise input signal exceeds the threshold value and when the monitoring means detects no speech input signal. In this case the monitoring means is preferably provided with means for, when the monitoring means detects no speech input signal, delaying inhibition of the attenuation of the input signal for a pre-determined time interval after the level of the noise input signal falls to or below the threshold level. The noise input signal is advantageously pre-set to a level less than the noise level at which normal speech is audible. The threshold level is preferably adjustable by the user.

Alternatively, the monitoring means is arranged to control the operation of the attenuator means to attenuate the input signal when the monitoring means detects no speech input signal, independently of the level of the noise input signal.

The attenuation means is, in operation, advantageously arranged to attenuate the input signal by approximately 10 to 20 dB. The degree of attenuation may be arranged to vary with noise frequency, preferably to be generally constant at lower noise frequencies and to increase at higher noise frequencies. As an example, the attenuation may be arranged to be in the region of 16 dB at

1KHz

The monitoring means may comprise a sensor for detecting the presence of a speech input signal, which sensor comprises a bandpass filter centered on the speech band, a level detector, and switching means for operating the attenuator means to inhibit attenuation of the input signal when a voice input signal is detected. The sensitivity of the speech level detector is preferably variable, and may be set at a level such that the monitoring means detects no speech input signal even when the input signal comprises a small speech component.

According to a further aspect of the present invention, there is provided a communication system, comprising an audio signal transmission circuit as described above.

In said system, the input is preferably linked to one or more microphones, and the attenuator output is linked to the communication system input.

Further features and advantages of the present invention will become apparent from the following description of an embodiment thereof, given by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a block diagram of a first embodiment of audio signal transmission circuit;

Figure 2 is a schematic view of signal waveforms in a first condition of the first embodiment of the audio signal transmission circuit;

Figure 3 is a schematic view of signal waveforms in a second condition of the first embodiment of the circuit;

Figure 4 is a schematic view of signal waveforms in a third condition of the first embodiment of the circuit; and

Figure 5 is a response plot for the embodiment of circuit of Figure 1.

The illustrated embodiment of audio signal transmission circuit comprises an input 1, which may for example be linked to one or more microphones (not shown) and an output 2 which may be linked directly or indirectly to a communication system input, which may comprise one or more ear pieces or headsets (not shown).

In the illustrated embodiment, signals from the input 1 pass through a buffer amplifier 3. These signals are then amplified by an amplifier 4 before being fed to the output of the circuit via a switchable attenuator 5. The level of attenuation is set such that, when the attenuator 5 is switched on, sufficient of any noise input signal is passed to reassure anyone monitoring the system output that the system is working normally. A normal value for the switching may be between 10 and 20 dB.

Monitoring means 6 are provided to control the operation of the attenuator 5. The monitoring means 6 comprise a parallel arm of the circuit for detecting the presence of a speech component in the signal at input 1. This detector circuit comprises a bandpass filter 7, centered on the speech band, and a level detector 8 to compare the signal with a pre-set level. If a speech component of appropriate level is present in the input signal the detector circuit 6 will register the presence of a speech input signal and activate switch 9, to switch the attenuator 5 to inhibit the attenuation of the input signal, so that the signal level at output 2 corresponds generally to that at the input 1.

The sensitivity of the level detector 8 may be optimised to suit the specific application of the attenuator circuit, and can depend on factors such as the likely noise input signal and the microphone type. In this way the sensitivity of the level detector 8 may be set such that the monitoring means 6 detects no speech input signal even when the input signal at input 1 includes a speech component.

As shown in Figure 2, when the monitoring means 6 detects a speech input signal, the detector circuit operates the attenuator 5 to allow both the noise input signal 10a and the speech input signal 10b to pass through largely unaffected. The signal waveform at the output 2 is shown at 10c.

When the monitoring means 6 detects no speech input signal 11b, and (at least) when the level of any noise input signal 11a exceeds a threshold level, the detector circuit 6 operates the attenuator 5 to attenuate the input signal 11a to produce an attenuated output 11c. In this way, anyone monitoring the system output will be prevented from the fatiguing effect of a high noise level in the output signal 11c, yet still be aware of the environment surrounding the input microphone(s).

In the event that the attenuator 5 is in operation, and the input signal at input 1 contains a speech component that is of too low a level (relative to the level set in level detector 8) for the monitoring means 6 to detect a speech input signal and hence inhibit the attenuation, it will be appreciated that the selection of the level of attenuation, such that when the attenuator is in operation a portion of the input signal is passed, also allows a portion of the speech component of the input signal to pass. This can have advantages when, for example, a microphone is linked to the circuit input 1 and the user ceases to speak, causing the attenuator to operate. Upon recommencing speech in this situation a portion of the speech component of the input signal will pass even if the user speaks too softly for the monitoring means 6 to detect a speech input signal. In this way, problems with clipping of the first syllable of speech can be overcome.

In the illustrated embodiment, the circuit includes a limb 12 comprising an amplifier 13, supplied with a signal from the output of buffer 3, and a level detector 14. This

level detector 14 has a reference level which may be adjusted to set the threshold level referred to above. The threshold level may advantageously be set to be below the noise level at which normal speech is audible and intelligible. The output of the level detector 14 is linked to the switch 9 so as to inhibit the attenuation of attenuator 5 when the noise level falls below the threshold level. The result is that, when the monitoring means 6 detects no speech input signal, the switch 9 operates the attenuator 5, to attenuate the input signal at input 1, only when the level of the noise input signal exceeds the threshold level of level detector 14. If the level of the noise input signal does not exceed this threshold level, the attenuator 5 is inhibited so that the noise input signal 15a (and any speech input signal 15b) is able to pass largely unaffected, as signal 15c. This has the advantage that in quiet conditions, when there is no noise input signal or the noise input signal 15a is below the threshold level of level detector 14, normal or even whispered speech can pass without attenuation.

In a modification of the illustrated embodiment, the additional limb 12 of circuitry may be omitted, with the result that, when the monitoring means 6 detects no speech input signal, the detector circuit 6 operates the attenuator 5, even at low noise levels, to attenuate the noise signal 11a to produce an attenuated output 11c. Compared to the illustrated embodiment, the omission of the additional limb 12 can be detrimental in that, when the attenuator means 5 has been operated as a result of the monitoring means 6 detecting no speech input signal, the speech level detector 8 may make it necessary for the person speaking into a microphone (not shown) to shout in order to deactivate the attenuator 5, to inhibit the attenuation, in order to be heard at the output 2.

The illustrated embodiment of circuit may comprise

means (not shown) for delaying the inhibition of the time attenuation of the noise input signal (when the monitoring means detects no speech input signal) for a pre-determined interval after the level of the noise input signal falls to or below the threshold level. These delay means may be adjustable. There may also be a delay in operating the attenuator 5, to attenuate the noise input signal should it rise to exceed the threshold level. This delay too may be adjustable. The former of these two time delays is preferably shorter than the latter, to provide a slow attack - fast decay operation, to protect anyone monitoring the output 2.

Attack - decay delays may also be provided in the operation of the speech detector circuit 7, 8, 9.

The plot in Figure 5 is of output in dB re Input (y-axis), against Frequency in Hertz (x-axis), the upper line representing the Figure 2 and 4 conditions, with the attenuator 5 not in operation, and the lower line representing the Figure 3 condition with the attenuator 5 in operation.

In Figure 5, the degree of attenuation is shown as being generally constant up to a frequency of approximately 500Hz, and as thereafter increasing with increasing frequency. This response characteristic has advantages when the circuit input 1 is linked to a microphone of the noise-cancelling type, since the noise-cancelling efficiency of such microphones generally decreases at high frequencies. By selecting the attenuation to increase at high frequencies (as shown), this variation in the noise-cancelling efficiency of the microphone can be at least partially offset.

The following data list gives sample values and performance figures for the illustrated embodiment of the circuit. This data and the plot of Figure 5 are given by way of example only.

ELECTRO-ACOUSTIC DATA

Bandwidth (through unit): 300Hz to 3.5KHz
Input level: 0.5 to 5.0mv rms (EM or electret)
Output level: as input, when speech is present
System gain: 0dB
Speech gate bandwidth: 800Hz to 1.2kHz
Speech attack time: <5ms
Speech hang time: 100ms to 1.5s
Speech detector circuit threshold: 0dB to -20dB referred to input level setting at 1kHz
Attenuation: 12dB at 500Hz; 24dB at 3kHz
Noise level detector threshold: 0dB to - 20dB referred to input level setting at 1kHz
Distortion: <5%
Noise gate bandwidth: 300Hz to 3.5kHz
Noise attack time: 1s approx
Noise hang time: 100ms approx

ELECTRICAL DATA

Supply Voltage: 18V nominal
Current: 15mA typical

CLAIMS:

1. An audio signal transmission circuit comprising attenuator means adapted to receive a combined speech and noise input signal and means for monitoring the input signal, said monitoring means being arranged to control the operation of said attenuator means to attenuate the input signal, when both the level of the noise input signal at least exceeds a threshold level and the monitoring means detects no speech input signal, by an amount such that at least a part of any noise input signal is continuously passed.

2. A circuit as claimed in claim 1, wherein the monitoring means is arranged to control the operation of the attenuator means to attenuate the input signal only when the level of the noise input signal exceeds the threshold level and when the monitoring means detects no speech input signal.

3. A circuit as claimed in claim 2, wherein the monitoring means is provided with means for, when the monitoring means detects no speech input signal, delaying inhibition of the attenuation of the input signal for a predetermined time interval after the level of the noise input signal falls to or below the threshold level.

4. A circuit as claimed in any of the preceding claims, wherein the noise input signal is adjustable to a level less than the noise level at which normal speech is audible.

5. A circuit as claimed in any of the preceding claims, wherein the threshold level is adjustable by the user.

6. A circuit as claimed in claim 1, wherein the monitoring means is arranged to control the operation of the

attenuator means to attenuate the input signal when the monitoring means detects no speech input signal, independently of the level of the noise input signal.

7. A circuit as claimed in any of the preceding claims, wherein the attenuator means is, in operation, arranged to attenuate the input signal by approximately 10 to 20 dB.

8. A circuit as claimed in any of the preceding claims, wherein the degree of attenuation is arranged to vary with noise frequency.

9. A circuit as claimed in claim 8, wherein the degree of attenuation is arranged to be generally constant at lower noise frequencies and to increase at higher noise frequencies.

10. A circuit as claimed in any of the preceding claims, wherein the attenuation is arranged to be in the region of 16 dB at 1 KHz.

11. A circuit as claimed in any of the preceding claims, wherein the degree of attenuation is adjustable by the user.

12. A circuit as claimed in any of the preceding claims, wherein the monitoring means comprises a sensor for detecting the presence of a speech input signal, the sensor comprising a bandpass filter centered on the speech band, a level detector, and switching means for operating said attenuating means to inhibit attenuation of the input signal when a voice input signal is detected.

13. A circuit as claimed in claim 12, wherein the sensitivity of the speech level detector is arranged at a

level such that the monitoring means detects no speech input signal even when the input signal comprises a small speech component.

14. A communication system comprising an audio signal transmission circuit as claimed in any of the preceding claims.

15. An audio signal transmission circuit substantially as herein described with reference to the accompanying drawings.

16. A communication system comprising an audio signal transmission circuit substantially as herein described with reference to the accompanying drawings.

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